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NASA TECH BRIEF

An Improved Atomic Hydrogen Frequency and Time Standard

The problem:

To develop a hydrogen maser frequency and time standard which is highly stable and accurate over long periods of time and suitable for tracking-station environments.

The solution:

Use of a large bulb, long-multipole magnet, automatic tuner and aluminum cavity provides an improved hydrogen maser.

How it's done:

Cost, size, weight, and the need for special training to operate the maser have been restraining factors in its widespread use in laboratories. When this problem was recognized work was started to improve the maser and develop auxiliary systems for its use by nonspecialists. An experimental model, which has been operating continuously since September 1967, is providing stable signals and further experimental data. Based on the experimental work, four complete prototype field operable standards have been designed and constructed and are, as of June 1969, all in operation and undergoing tests.

The new model, which utilizes an aluminum cavity, provides several advantages: (1) electrically opaque, (2) reproducible high Q, (3) mechanically stable, (4) readily available and, (5) inexpensive. The large thermal expansion, fifty times that of fused silica, can be used advantageously to tune the cavity. This eliminates the need for problematic mechanical tuners, or varactor diode tuning methods. Long-term cavity drifts, although small, are corrected completely by a unique automatic cavity tuner which is part of the system.

One improvement incorporated by this maser is the use of a bulb much larger than usual. Use of the large bulb is based upon operation of the cavity very near waveguide cutoff diameter, where the frequency depends primarily upon diameter and loading, while the length may be increased as desired.

Modifications have been made to the state selector, for example, a long, small bore, high-flux multipole magnet is used to "capture" the maximum possible flux of upper state atoms from the source, and to remove the lower state atoms from the beam. The long magnet was found to be desirable because it assures that a larger number of atoms actually enter the bulb.

Notes:

1. The information described in this innovation may be of interest to personnel working with masers and atomic frequency standards.
2. Documentation is available from:
   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: TSP69-10341

Patent status:

No patent action is contemplated by NASA.

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